

COURSE OUTLINE

Course Title: Internetworking: Levels 3 and 4

CBEDS Title: Telecommunications

CBEDS No.: 4618

Job Titles **DOT No.**

Network Support Specialist
Network Control Technician
LAN/WAN Technicians
Network Specialists
Network Systems Technician
Cisco-Certified Network Technician

Course Description:

This is the second of two courses designed to provide students with classroom and laboratory experience in current and emerging networking technology that will empower them to enter employment and/or further education and training in the computer networking field. Content standards are based on a task analysis of current industry/occupational standards. The first half of this course includes switches; LAN and virtual local area network (VLAN) design, configuration, and maintenance; internetwork packet exchange (IPX) routing and interior gateway routing protocols (IGRPs); and network troubleshooting. The second half of the course includes wide area networks (WANs), integrated services data networks (ISDNs), point-to-point protocols (PPPs), and frame relay design, configuration, and maintenance. Students develop practical experience in skills related to configuring WANs, ISDN, PPP, and frame relay protocols and network troubleshooting. Integrated throughout the course are career preparation standards, which include basic academic skills, communication, interpersonal skills, problem solving, safety, technology, and other employment skills.

Prerequisites: Internetworking 1 & 2 or the equivalent

Total Hours: 180 hours of classroom instruction and up to 240 hours of work-based learning at community training sites.

COURSE OUTLINE

INTERNETWORKING: LEVELS 3 AND 4

Upon successful completion of this course, students will be able to demonstrate advanced skills necessary for employment.

Additional hours for career preparations standards are integrated into instruction in content area standards.

Classroom
Hours

I. CAREER PREPARATION STANDARDS

30

- A. Understand how personal skills development--including positive attitude, honesty, self-confidence, time management, and other positive traits--affect employability.
 - 1. Demonstrate an understanding of classroom policies and procedures.
 - 2. Discuss importance of the following personal skills in the business environment:
 - a. Positive attitude
 - b. Self-confidence
 - c. Honesty
 - d. Perseverance
 - e. Self-management/work ethic
 - f. Pride in product/work
 - g. Dependability
 - 3. Identify acceptable business attire.
 - 4. Establish goals for self-improvement and further education/training.
 - 5. Prioritize tasks and meet deadlines.
 - 6. Understand the importance of initiative and leadership.
 - 7. Understand the importance of lifelong learning in a world of constantly changing technology.
- B. Understand principles of effective interpersonal skills, including group dynamics, conflict resolution and negotiation.
 - 1. Identify and discuss behaviors of an effective team.
 - 2. Explain the central importance of mutual respect in workplace relations.
 - 3. Discuss and demonstrate strategies for conflict resolution and negotiation and explain their importance within the business environment.

4. Understand laws that apply to sexual harassment in the workplace and identify tactics for handling harassment situations.
5. Work cooperatively, share responsibilities, accept supervision, and assume leadership roles.
6. Demonstrate cooperative working relationships and proper etiquette across gender and cultural groups.
- C. Understand the importance of good academic skills, critical thinking, and problem-solving skills in the workplace.
 1. Recognize the importance of good academic skills in information technology and implement a plan for self-improvement as needed.
 2. Use mathematical concepts in application of skills, techniques, and operations.
 - a. Mathematical concepts
 - b. Algebra concepts
 - c. Binary numbers
 - d. Additional higher-level math concepts as applicable
 3. Use scientific concepts in application of skills, techniques, and operations.
 - a. General science concepts
 - b. Physical science concepts
 - c. Additional science concepts (biology, physics, and chemistry, as applicable)
 4. Read, write, and give directions.
 5. Demonstrate skills in technical reading and writing.
 6. Locate information from written and electronic sources and identify strategies for evaluating their reliability and validity.
 7. Exhibit critical and creative thinking skills and logical reasoning skills and employ these skills for problem solving.
 - a. Work as a team member in solving problems.
 - b. Diagnose the problem, its urgency, and its causes.
 - c. Identify alternatives and the consequences.
 - d. Explore possible solutions.
 - e. Compare/contrast the advantages and disadvantages of alternatives.
 - f. Determine appropriate action(s).
 - g. Implement action(s).
 - h. Evaluate results of action(s) taken.
- D. Understand principles of effective communication.
 1. Use communication concepts in application of skills, techniques, and operations.
 - a. Prepare written material.
 - b. Analyze written material.

2. Understand and implement written instructions from technical manuals, documents, and reference books.
 3. Present a positive image through verbal and nonverbal communication, and understand the power of body language in communication.
 4. Demonstrate active listening through oral and written feedback.
 5. Give and receive feedback.
 6. Demonstrate assertiveness in communication in both oral and written.
 7. Demonstrate proper etiquette in business communications, including an awareness of requisites for international communications (languages, customs, time zones, currency and exchange rates).
 8. Demonstrate writing/editing skills as follows:
 - a. Write, edit, and proofread business correspondence.
 - b. Use correct grammar, punctuation, capitalization, vocabulary, and spelling.
 - c. Select and use appropriate forms of technology for communication.
 9. Exhibit proficiency in the use of reference books.
 10. Research, compose and orally present information for a variety of business situations using appropriate technology.
- E. Understand occupational safety issues, including avoidance of physical hazards.
1. Discuss and implement good safety practices, including the following:
 - a. Personal
 - b. Lab
 - c. Fire
 - d. Electrical
 - e. Equipment
 - f. Tools
 - g. Interpretation of Material Safety Data Sheets
 - h. Environmental Protection Agency
 - i. Occupational Safety and Health Administration
 - j. American Red Cross Standards
 - k. Networking safety standards
 2. Apply sound ergonomic principles in organizing one's work space.

- F. Understand career paths and strategies for obtaining employment.
 - 1. Explore career opportunities and projected trends; investigate required education, training, and experience; and develop an individual education plan.
 - 2. Identify steps for setting goals and writing personal goals and objectives.
 - 3. Examine aptitudes related to career options, and relate personal characteristics and interests to educational and occupational opportunities.
 - 4. Develop a career portfolio containing the following documents:
 - a. Job application
 - b. Résumé(s)
 - c. Appropriate cover and follow-up correspondence
 - 5. Identify and demonstrate effective interviewing techniques.
- G. Understand and adapt to changing technology.
 - 1. Explain how people, information, tools, machines, energy, capital, physical space, and time influence the selection and use of networking technologies.
 - 2. Demonstrate the ability to use personal computers for loading and retrieving data, information gathering, measurements, and writing about and explaining computer networking.
 - 3. Explain the importance of adapting to change, being flexible, and evaluating goals when working in the computer networking industry.
 - 4. Understand the importance of lifelong learning in adapting to changing technology.
- H. Understand the importance of ethics in information technology fields.
 - 1. Discuss the social and ethical responsibilities of having access to information.
 - 2. Discuss rights to privacy in regard to information.
 - 3. Understand that copyright violations constitute theft.
 - 4. Discuss copyright laws and distinguish copyright violations in a variety of situations.
 - 5. Demonstrate ethical choices in workplace situations.
 - 6. Distinguish between First Amendment freedoms and access to information.

II. SWITCHES

20

- A. Demonstrate an understanding of half-duplex Ethernet design.
 1. Define and apply RX (receive) and TX (transmit) method of transmission.
 2. Demonstrate the use of carrier sense multiple access/collision detect (CSMA/CD) applications to collision detection.
- B. Explain the concepts of congestion and bandwidth and their application to switched Ethernet LANs.
- C. Demonstrate the increased capabilities of applications when segmenting with LAN switches.
 1. Define switches application to larger files.
 2. Explain the OSI model level as it is applied when there is an increase in the number of files and users.
 3. Explain the function of a switch in propagation delay (latency).
 4. Summarize microsegmentation as it relates to Ethernet transmission times.
 5. Explain how switches operate when dealing with distance and attenuation issues.
- D. Design a plan to decrease latency with switches when repeaters are present.
- E. Understand and define a full duplex Ethernet network.
- F. Demonstrate the functions involved in analyzing bidirectional traffic and understand collision-free traffic.
- G. Explain the operation of a full duplex Ethernet and summarize the typical inherent problems associated with full operation.
- H. Design a plan improving LAN performance that illustrates the processes LAN switches use to learn addresses; include the following in the illustration or be able to explain and/or demonstrate the following concepts in the plan:
 1. Segmenting
 2. Segmenting steps
 3. Dynamic steps
- I. Using the concepts of segmentation and collision domains, solve a problem related to the low latency of LAN switches.
- J. Recommend a method for applying the processes of Segmenting by using bridges to increase bandwidth.
- K. Create a virtual circuit.
- L. Define and describe the benefits of the following:
 1. Switching
 2. Symmetric switching

3. Asymmetric switching
 - M. Demonstrate the process of segmenting by using bridges and the effect on the following:
 1. OSI model level
 2. Operation
 3. Increased latency
 - N. Define and demonstrate the function, operation, and types of memory buffer.
 - O. Explain and demonstrate segmenting by using routers and the respective effect on the following:
 1. OSI model level
 2. Function
 3. Increased latency with routers operation
 - P. Compare and contrast the two types of memory buffer:
 1. Port-based memory buffer
 2. Shared memory buffer (dynamic)
 - Q. Compare and contrast the following switching methods; explain the advantages of the following:
 1. Store and forward
 2. Cut-through
 - R. Summarize spanning tree protocol and explain the operation and function of spanning tree protocol as it involves the following:
 1. Loops
 2. Bridge protocol data units with STP advantages
 - S. Compare and contrast the advantages and disadvantages of using half-duplex Ethernet and full duplex Ethernet.
 - T. Recommend a solution to a problem that requires the application of either a half-duplex Ethernet or a full duplex Ethernet; defend the recommendation.
- III. VIRTUAL LANs (VLANs)
- A. Define and explain the functions and benefits of a VLAN.
 - B. Explain the uses of switches in VLANs.
 - C. Demonstrate reorganizing user locations in VLANs; explain the process used.
 - D. Describe the advantages of using a VLAN.
 - E. Set up a VLAN.
 1. Summarize the process used.
 2. Paraphrase the benefits.
 - F. Define and describe the operation of frame filtering by switches.
 - G. Define and explain the operation of firewall segmentation for broadcast.
 - H. Compare and contrast the advantages of using firewall segmentation for broadcast.

20

- I. List and summarize the IEEE 802 VLAN standards.
 - J. Describe and discuss the operation and advantages of frame tagging.
 - K. Explain the benefits and operation of broadcast domains in VLANs.
 - L. Define and describe the process used to lower the number of broadcast storms.
 - M. Summarize the operation and benefits of using legacy hubs.
 - N. State a typical problem in which controlling the broadcast domain size is the solution; explain the solution.
 - O. Explain the operation of VLAN network security.
 - P. Describe and be able to identify the processes used to transport VLANs across backbones.
 - Q. Given a scenario in which VLANs are transported across backbones, describe how each of the following contribute transport:
 - 1. Segmentation
 - 2. Number of users
 - 3. Access lists
 - R. Compare and contrast the initial configuration and configuration changes involved in the following:
 - 1. Port-centric VLANs
 - 2. Dynamic VLANs
- IV. LAN DESIGN
- A. Define and explain the LAN design goals of each of the following:
 - 1. Functionality
 - 2. Scalability
 - 3. Adaptability
 - 4. Manageability
 - B. Design a LAN and justify and/or document the decisions made about each of the following design characteristics:
 - 1. Design methodology.
 - 2. Analyze requirements and document.
 - 3. Identify and justify decisions concerning business issues.
 - 4. Identify and justify decisions concerning technology issues.
 - 5. Identify and justify decisions concerning administrative issues.
 - 6. Develop a LAN using both a star and extended star topology.
 - 7. Document the IP addressing scheme.

20

- C. Set up a VLAN implementation plan.
 - 1. Gather and analyze network requirements.
 - 2. Analyze and document a customer's LAN requirements.
 - 3. State the customer's problem in writing.
- D. Design a network.
- E. Describe and document the criteria used to address the following:
 - 1. Speed
 - 2. Expansion
- F. Document the purpose and source of the devices chosen for layer 2; specify and justify bridges and switches used.
- G. Document the purpose and source of the devices chosen for layer 3; specify and justify routers used.
- H. Distinguish between the following network types and choose a document server appropriate to each of them:
 - 1. Enterprise
 - 2. Workgroup
- I. Documentation must include illustrations and justifications for each of the following:
 - 1. Physical layer(s)
 - 2. Logical application
 - 3. Addressing maps
 - 4. Reasons for documentation
- J. Explain path determination in network layer, and describe and identify the differences in router function and network layer function.
- K. Compare and contrast network addresses and host addresses in network layer addressing.
- L. Configure IGRPs by using the following:
 - 1. Global tasks
 - 2. Interface tasks
- M. Demonstrate IGRP configuration tasks.
- N. Define and summarize the purpose of routed versus routing protocols.
- O. Demonstrate network layer protocol operation.
- P. Do a multiprotocol routing.
- Q. Define and explain the difference in operation of static versus dynamic protocol routing.
- R. Demonstrate typology changes.
- S. Define and conduct a dynamic routing operation and identify and document the resultant metrics changes.

- T. Compare and contrast the various classes of routing protocols including the following:
 - 1. Distance vector
 - 2. Hybrid
 - 3. Link state
- U. Explain convergence and be able to define and document its occurrence.
- V. Define and be able to identify and document when the following types of IP routing occurs:
 - 1. Static routes
 - 2. Default routes
 - 3. Dynamic routing
- W. Define and give the purpose and operational characteristics of the following:
 - 1. Autonomous system
 - 2. Internal/external routing protocol
 - 3. IGRP
- X. Illustrate and explain composite metric.
- V. **ACCESS CONTROL LISTS** **20**
 - A. Define and describe the purpose and operation of the following:
 - 1. Standard access lists
 - 2. Extended access lists
 - B. Create a list of deny/permit tests; explain the difference.
 - C. Define and explain the function and operation of wildcard masks bits.
 - D. Create an access list that illustrates configuration Commands, including global statements and interface commands.
 - E. Summarize how to identify access lists.
 - F. Explain and conduct the processes involved for testing packs with access lists.
 - G. Create an IP access list by using the following:
 - 1. Wildcard mask bits
 - 2. Wildcard any
 - 3. Wildcard host
 - H. Configure IP with standard access.
 - I. Configure extending IP with access lists by using named IP access list.
 - J. Document location of IP access list.
- VI. **NOVELL IPX** **20**
 - A. Explain the features of Cisco routers used in a Novell network.
 - B. Discuss the difference between Novell IPX and other networks.
 - C. Compare the features of Novell netware with known non-Novell netware.

- D. Configure a Novell network by using Novell IPX addresses.
 - 1. Network number
 - 2. Network node
 - E. Explain the process of determining IPX addresses.
 - F. Illustrate the operation of distance vector routing protocols.
 - G. Define and explain the purpose and the dynamic of SAP broadcast.
 - H. Name, define, and summarize Cisco encapsulation names.
 - I. Conduct a Novell RIP routing.
 - J. Configure a Novell IPX network by using the following:
 - 1. Global tasks
 - 2. Interface tasks
 - K. Verify an IPX operation by monitoring the following document the monitoring activities.
 - 1. Routing tables
 - 2. IPX servers
 - 3. IPX traffic
 - L. Troubleshoot a Novell network by documenting the following:
 - 1. IPX routing
 - 2. IPX SAP
- VII. WIDE AREA NETWORKS (WANs)
- A. Understand the basics of WANs, including common WAN technologies, types of wide area services, encapsulation formats, and link options.
 - 1. Understand and describe the purpose of WANs.
 - 2. Describe the various WAN devices.
 - 3. Understand and be able to apply the standards in WANs.
 - 4. Understand and apply WAN operation at the physical layer.
 - 5. Understand and apply WAN operation at the data link layer.
 - 6. Understand and interface with WAN service providers.
 - 7. Understand the use of WAN services with routers.
 - 8. Understand WAN encapsulation formats, including the following:
 - a. Protocols
 - b. Serial line encapsulation
 - c. High-level data link control (HDLC)
 - d. Point-to-point protocol (PPP)

20

- B. Understand WAN link options, including the following:
 - 1. Standards/capacities
 - 2. Dedicated
 - 3. Switched
 - 4. Dial on demand
- C. Understand the process and considerations for designing a hierarchical model of a WAN.
 - 1. Understand the process for gathering data about the needs of the user; gather user data.
 - 2. Understand the benefits of using a hierarchical design model.
 - 3. Understand the three layers of the hierarchical model and their functions.
 - 4. Describe placement of integrated services data network (ISDN) and frame relay.
 - 5. Understand the impact on traffic of placement of the enterprise and workgroup servers.
- D. Design a hierarchical WAN model.
- E. Implement a hierarchical WAN model.

VIII. POINT-TO-POINT PROTOCOL (PPP) 10

- A. Understand the components, process, and operation of PPP communication.
 - 1. Understand the basic components of PPP communication.
 - 2. Describe PPP's connection negotiation process.
 - 3. Understand the use of link control protocol (LCP) and network control protocol (NCP) frames in PPP.
- B. Understand the process for configuring and verifying PPP.
 - 1. Negotiate a PPP connection.
 - 2. Configure and verify a PPP connection.

IX. INTEGRATED SERVICES DIGITAL NETWORK (ISDN) 10

- A. Understand the services, standards, components, operation, and configuration of ISDN communication.
 - 1. Understand and articulate why ISDN is used.
 - 2. Understand and be able to describe the special services offered by ISDN communication.
 - 3. Understand and apply the standards of ISDN.
 - 4. Understand the components of ISDN.
 - 5. Understand the operation of ISDN.
 - 6. Understand the process for configuring and verifying ISDN.
- B. Configure and verify an ISDN connection.

X.	FRAME RELAY	10
A.	Understand the services, standards, components, operation, and configuration of frame relay communication.	
	1. Understand and use the basic devices of frame relay.	
	2. Understand the functions of data-link connection identifier (DLCI) in frame relay.	
	3. Understand the operation of frame relay.	
	4. Understand the issue of split horizon.	
	5. Understand sub-interface.	
	6. Understand how frame relay uses sub-interfaces to solve the problem of split horizon.	
	7. Understand the process for configuring and verifying frame relay on router interfaces.	
	8. Understand the process for configuring frame relay sub-interfaces.	
B.	Configure a frame relay by using the following:	
	1. Sub-interfaces	
	2. DLCI functions	
XI.	WORK-BASED LEARNING	240
	Apply information technology skills in workplace settings.	
Total hours:		180 240